DECHENELLID TRILOBITES FROM THE BRITISH MIDDLE DEVONIAN

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By E. B. SELWOOD

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SYNOPSIS

Dechenella has a restricted occurrence in South West England. A single species only is known, *Dechenella* (*Dechenella*) *setosa* Whidborne, 1889. This is redescribed and variation seen in the pygidia and cranidia is examined. The species is bimorphic, each bimorphic group of pygidia showing a range of variation that can be correlated with size and hence presumably with age. The species is probably of late Couvinian age.

I. INTRODUCTION

Although *Dechenella* is a characteristic Middle Devonian genus with a wide distribution, relatively few species are known, and in Britain only one species, *Dechenella setosa*, has been recognised. This species, unknown outside Devonshire, was first described by Whidborne (1889, 1889*a*) from the Middle Devonian Limestones at Chercombe (sometimes spelt Chircombe or Cherecombe) Bridge near Newton Abbot, and subsequently redescribed by Richter (1912). Much of the museum material is incompletely localized but from the lithologies it seems that, with rare exceptions, all comes from an extensive disused quarry on the north bank of the River Lemon, 200 yards east of Chercombe Bridge (National Grid Reference: SX832711), where 70 feet to 80 feet of well bedded limestones are still exposed. The individual limestone beds, which vary in thickness from a few inches to several feet, are dominantly pale grey in colour and yield a fauna of brachiopods, corals, stromatoporoids and polyzoa. In the higher structural horizons of the quarry there are, interbedded with these pale limestones, horizons of dark bituminous limestone (which are no doubt the "black marbles" yielding trilobites mentioned by Whidborne 1889*a*: 28).

Recent collecting in this quarry has failed to produce any trilobites from the pale coral limestone, but much new material has been obtained from one horizon, 12 inches thick, of black fine-grained limestone exposed in an overgrown section at the entrance to the quarry, a few yards east of the old lime kiln. This is a lithology identical to that of the museum material, and there seems no reason to doubt that the earlier collectors found a similar restricted distribution of trilobites. Two specimens in the British Museum (Natural History) are labelled "West Hill, East Ogwell" and were probably collected from the largely overgrown quarry south-east of Chercombe Bridge. Searching in this quarry has yielded a further pygidium from a lithology identical to that in the Chercombe Bridge Quarry. The West Hill quarry lies only 100 yards along the strike from the latter quarry, and it is most likely that the same horizons are represented in both quarries.

A significant difference exists between the old collections and those made recently; Whidborne based his description of the species upon 37 pygidia and 2 cranidia, and in all the museum material examined a preponderance of pygidia exists, but recent collecting has demonstrated that pygidia and cranidia occur in approximately equal numbers. This strongly suggests bias in the original collecting. As the material is sparsely distributed through the rock, it is likely that much of it was collected by workmen in the quarry as chance finds came to light. Such collecting would undoubtedly be biased in favour of "attractive" specimens; in this case, the perfectly preserved pygidia certainly catch the eye much more readily than the dissociated cranidia and free cheeks.

Sufficient material is now available to show that there is, particularly in the pygidia, a considerable variation of morphological features. Although comparisons of extreme variants might suggest that more than one species is involved, the variation appears to be continuous and there is no reason to suspect the presence of more than one species. The sample is interpreted as an assortment of individuals of different ages, since it is most unlikely that any of the material was collected through a considerable thickness of sediment.

There is a notable absence of larval and small specimens in the museum material, and a similar gap has been found in recent collecting. This suggests that their absence is to be accounted for by some ecological factor, and that only adults migrated into the area.

Since the published descriptions do not take account of the variation, and particularly since the pygidium described by Richter (1912) is not characteristic, the variation of *Dechenella setosa* is first described and the species then redefined in more general terms.

II. ACKNOWLEDGMENTS

I wish to thank particularly Dr. W. T. Dean and Professor S. Simpson, who read and criticized the original manuscript, and Mr. J. Saunders, technician in the Department of Geology at Exeter, who rediscovered the trilobite band and gave valuable assistance in subsequent collecting. Mr. Saunders is also responsible for the photographs.

Dr. R. C. Blackie (Exeter City Museum), Mr. A. G. Brighton (Sedgwick Museum, Cambridge), Dr. W. T. Dean (British Museum (Natural History)), Dr. J. D. D. Smith (Geological Survey and Museum), and Dr. F. S. Wallis (Torquay Natural History Museum) kindly permitted the examination and arranged the loan of specimens in their care. Dr. W. Struve allowed me to see type material of Continental species held in the Senckenberg Museum, Frankfurt-am-Main. This part of the work was completed whilst in receipt of a travel grant from the British Council; this is gratefully acknowledged.

III. VARIATION

Measurements have been made on the pygidia of 44 specimens and, where possible, four standard measurements taken; the breadth of pygidium (Bp), the breadth of axis (Ba), the length of pygidium (Lp), and the length of axis (La) (Text-fig. 1, Table I).

TABLE I

	Mean	*Standard Deviation*
Breadth of pygidium	16·79 ± 1·479	4·89
Length of pygidium	12·04 ± 1·026	3·39
Breadth of axis	4·31 ± 0·368	1·22
Length of axis	10·43 ± 0·884	2·92

All measurements in millimetres

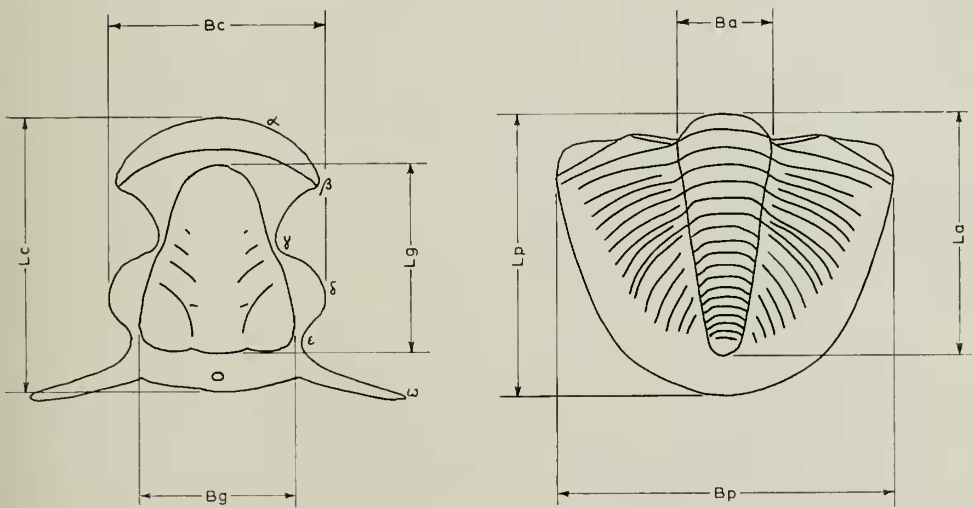

FIG. 1. Standard measurements of cranidia and pygidia of *Dechenella setosa*. Bc, breadth of cranidium; Bg, breadth of glabella; Lc, length of cranidium; Lg, length of glabella. Bp, breadth of pygidium; Ba, breadth of axis; Lp, length of pygidium; La, length of axis.

Frequency diagrams of dimensions and ratios of different dimensions are consistent with the hypothesis that all specimens can be referred to a single species, since each shows a single well defined peak.

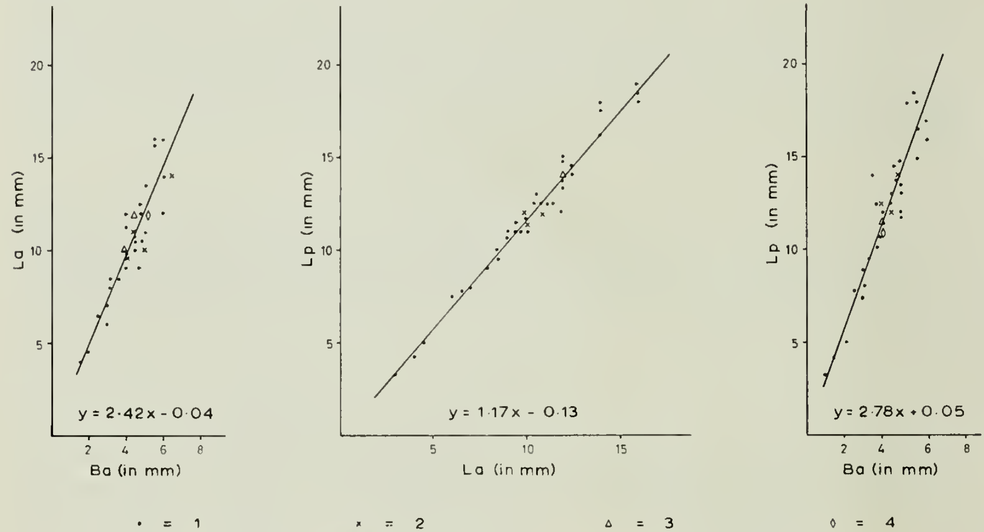

FIG. 2. Scatter diagrams showing variation in pygidia of *Dechenella setosa*. The reduced major axis is included for each scatter.

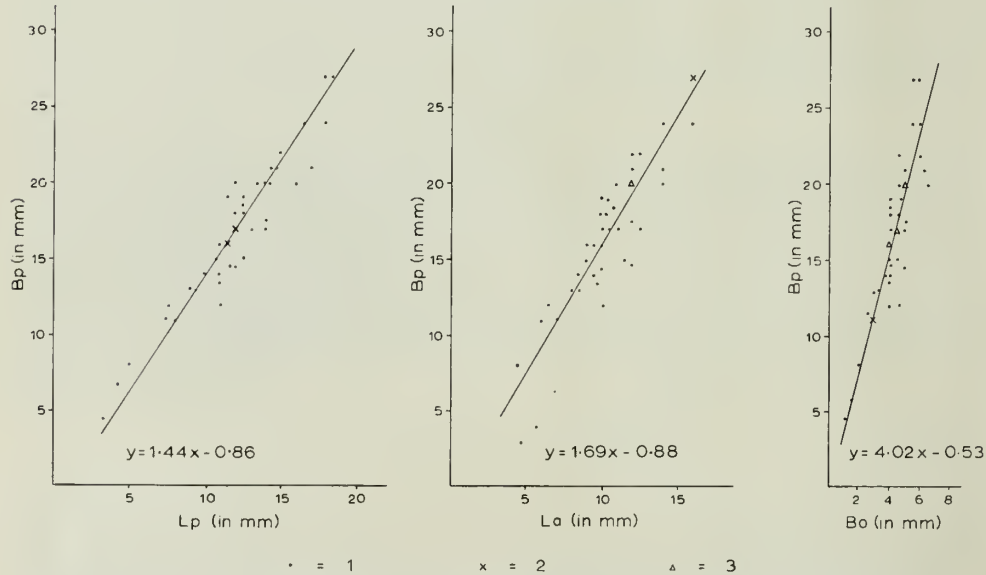

FIG. 3. Scatter diagrams showing variation in pygidia of *Dechenella setosa*. The reduced major axis is included for each scatter.

Scatter diagrams (Text-figs. 2, 3) relating the length of the standard measurements show, on arithmetic co-ordinates, a markedly rectilinear distribution. The reduced major axis ($y=b+kx$) has been drawn for all scatters (see Miller & Kahn 1962 : 204), and these clearly indicate that the sample may be interpreted as a single species showing isometric growth. In the absence of young and larval specimens, it is not possible to state the course of the reduced major axis when extrapolated downwards into the smaller size ranges, but from the known ontogenies of trilobites (Palmer 1958) it is probable that the growth here is allometric.

TABLE II

	Reduced major axis	*Correlation coefficient*	*Standard error of slope*	*Standard error of intercept*	*Dispersion around R.M.A.**	*No. of specimens*
Lp/Bp	1·44x −0·86	0·94	0·076	0·095	2·062	42
Ba/Lp	2·78x +0·05	0·94	0·141	0·634	1·205	42
Ba/Bp	4·02x −0·53	0·89	0·187	1·287	2·399	42
Ba/La	2·42x −0·04	0·90	0·160	0·174	1·387	44
La/Lp	1·17x −0·13	0·99	0·024	0·256	0·589	42
La/Bp	1·69x −0·88	0·92	0·090	1·033	2·091	42

* R.M.A. — Reduced major axis

When the detailed characteristics of the pygidia are examined, much variation can be observed which is closely related to the size, and hence presumably to the age, of the individuals. At the same time, the sample falls into two groups of approximately equal number, each showing the variation suggested to be associated with age. The two groups may be distinguished by the character of the axial furrows: in Group A they are weakly constricted between rings 7–8, whilst in Group B they are straight (Text-fig. 4). The measured characters of the pygidium are quite independent of the bimorphic characters, specimens referred to Groups A and B show a random distribution within all of the scatters prepared in Text-figs. 2 and 3.

Bimorphic variation has also been recorded amongst the cranidia. The glabellas of specimens referred to Group C are more pointed than those of Group D, and β on the anterior branch of the facial suture is placed more anteriorly in Group C than in Group D. In side view, the occipital ring is seen to lie below the level of the glabella in Group C, whilst it reaches the height of the posterior part of the glabella in Group D. Ornamentation in the form of a fine granulation has only been observed on the glabella of specimens belonging to Group D (Text-fig. 5).

The bimorphism described above is probably sexual but the lack of complete specimens makes it impossible to determine if a correlation exists between the bimorphism seen in the pygidia and cranidia. When comparisons are made with other species (page 331) it is found that, although the range of variation of *Dechenella setosa* would appear to include a number of species, there is some correlation between those features which distinguish the bimorphic individuals of *Dechenella setosa*, and those which distinguish the species *Dechenella verneuili* and *Dechenella rittbergensis*.

It is thus tempting to ascribe the cranidium D to pygidium A (both showing *verneuili* characters) and cranidium C to pygidium B (both showing *rittbergensis* characters). Verification can only await the discovery of complete specimens.

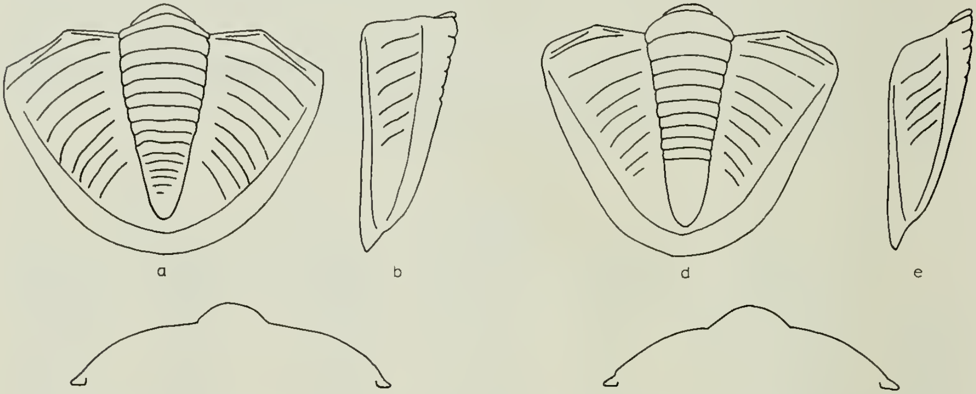

Fig. 4. Pygidia of *Dechenella setosa*. Group A. (a) Plan view, note constricted axis; (b) Side view; (c) Posterior view. Group B. (d) Plan view, note straight axis; (e) Side view; (f) Posterior view.

Both pathological and cicatrized pygidia have been observed in the sample, and it is evident that the species possessed considerable powers of regeneration (Pl. 1, fig. 8).

IV. AGE OF THE FAUNA

Both *Calceola sandalina* (Linné) and *Stringocephalus burtini* Defrance have been recorded from the Chercombe Bridge Quarry (Ussher 1913 : 20). Although neither has been positively identified during the present investigation, Middleton (1959) has confirmed that the limestones are at least in part of middle Middle Devonian age.

Richter (1912) suggested that *Dechenella setosa* was of Givetian age, and this is supported by the acknowledged Givetian age of all the closely related species. However, *Scutellum* (*Scutellum*) *flabelliferum* (*Goldfuss*) also occurs in the same horizon; this trilobite is a characteristic Couvinian form. A somewhat stronger case can thus be made out for a Couvinian age, though the presence of *Stringocephalus burtini* in the same quarry must indicate an horizon near to the Couvinian/Givetian boundary.

The limestones of the quarry have so far failed to yield conodonts.

V. ECOLOGY AND DISTRIBUTION

Since the trilobites are restricted to the black limestone, it seems that sea floor conditions controlled their distribution and that the species was benthonic. The fine-grained bituminous character of the limestone, the presence of pyrite and the great reduction of coral and stromataporoid growth suggest bottom sediments

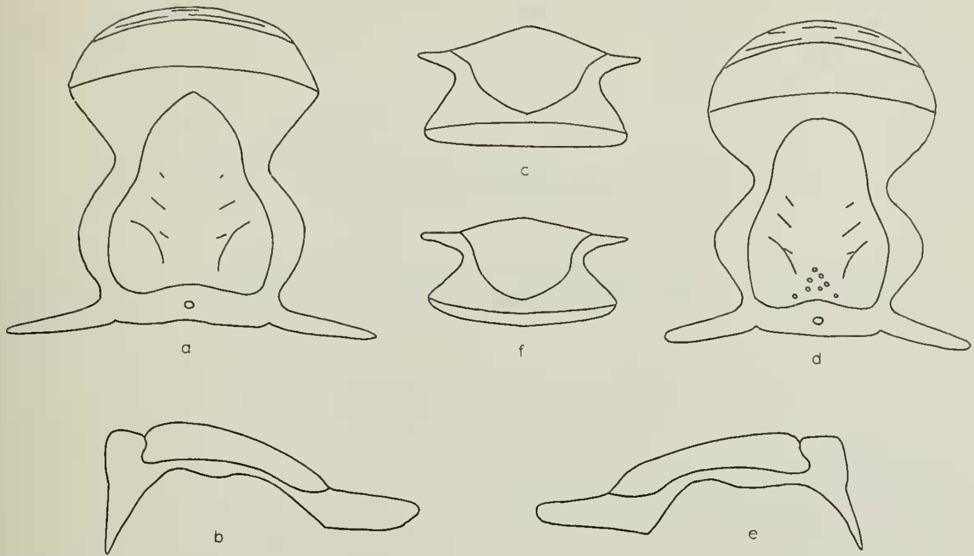

FIG. 5. Cranidia of *Dechenella setosa*. Group C. (a) Plan view, anterior of glabella pointed; (b) Side view, occipital ring low; (c) Anterior view. Group D. (d) Plan view, glabella rounded anteriorly, posterior surface of glabella granulated; (e) Side view, occipital ring high; (f) Anterior view.

containing a considerable amount of decaying organic matter; such an environment would be well-suited to mud feeding organisms. The absence of young and larval stages from the sample might be explained by these stages being planktonic and settling on to the sea floor only on reaching maturity. Small thin shelled bivalves and the trilobite *Scutellum* (*Scutellum*) *flabelliferum* occur together with the dechenellid trilobites. *Scutellum* occurs in a wide variety of lithologies in the Torquay district and was probably planktonic. The distribution of the fauna would not seem to be entirely dependent upon ecological conditions, for comparable lithologies to that yielding the dechenellid trilobites exist both in the Chercombe Bridge Quarry and in many of the other Middle Devonian Limestone outcrops in the South Devon area. To some extent the localization of the fauna may be more apparent than real in that much collecting remains to be done, but at the same time the main limestone outcrops have been extensively quarried in the past and it is surprising that more specimens have not come to light.

The variation seen in *Dechenella setosa* does not suggest that the British species evolved in isolation, for it shows a range of variation allowing close comparisons to be made with species described from the Rhenish Mountains, Morocco, and Bohemia (page 331). It is suggested that the centre of dispersal of European Middle Devonian dechenellids lay some distance outside the British area and that the record at Chercombe Bridge represents an isolated and unusual migration into the British area. Since the adult specimens of *Dechenella setosa* were probably benthonic, the isolated occurrence might be explained by the chance distribution of planktonic larvae in currents.

VI. SYSTEMATIC DESCRIPTION

Family **PROETIDAE** Salter 1864
Subfamily **DECHENELLINAE** Přibyl 1946
Genus ***DECHENELLA*** Kayser 1880
Subgenus ***DECHENELLA*** Kayser 1880

Dechenella (Dechenella) setosa Whidborne

(Pl. 1, Text-figs. 1–6)

1889 *Dechenella setosa* Whidborne: 29.
1889 *Dechenella setosa* Whidborne: 27, pl. 2, figs. 15-17.
1912 *Dechenella* (*Eudechenella*) *setosa* Whidborne; Richter : 310, pl. 20, figs. 8, 9.
1950 *Dechenella* (*Dechenella*) *setosa* Whidborne; Richter, R. & E.: 178.

Diagnosis. A bimorphic species of *Dechenella* with weakly impressed glabellar furrows. The frontal area is large and more than one quarter of the total length of the glabella at the sagittal line. The anterior border is broad. Specimens of Group C are distinguished from those of Group D by their smooth, more pointed glabellas. The axis of the pygidium is narrow and constricted between rings 7 and 8 in Group A, but straight in Group B. The length of the pygidium is more than three fifths of its maximum breadth. 18 rings and 12 ribs may be distinguished clearly. The pleural furrows are narrow and deep anteriorly but they shallow and widen posteriorly.

Lectotype. Cephalon (BM., I. 5039). Pl. 1, fig. 14. Designated by Richter, R. & E. (1950).

Locality and Horizon. Chercombe Bridge Quarry (Nat. Grid Ref. SX832711), near Newton Abbot, Devon; Middle Devonian, probably late Couvinian.

Additional material. The following specimens exemplify the characteristic features of each of the four groups of *Dechenella setosa* described in this paper:

Group A, GSM.6987 (Pl. 1, figs. 1–3); Group B, BM., I. 5056 (Pl. 1, figs. 5–7); Group C, BM., I. 5039 (Pl. 1, fig. 14); Group D, BM., IT.101 (Pl. 1, fig. 10).

DESCRIPTION

Cranidium. Side view. The glabella is broadly curved. From the crestal point, lying one third of the distance from the glabella posterior to the glabella anterior, the glabella descends quite steeply to the pre-glabellar field, but rather more steeply in Group D than in Group C. The preglabellar field declines gently forwards and passes into a broadly concave anterior border furrow. The anterior border is gently inflated and rises at a low angle from the border furrow, but then falls sharply to the margin. The occipital furrow is deep and rounded and passes posteriorly into a symmetrical and flattened occipital ring. This ring continues the curve of the glabella in Group D but falls slightly below this in Group C. In sectioned material, the posterior border of the occipital ring is seen to be reflexed onto the ventral surface and is carried forward for a distance equivalent to half the length of the occipital ring.

Frontal View. In profile, the glabella is weakly triangular and rises gently and regularly from poorly defined axial furrows to the sagittal line. The weak keel so developed is more evident in Group C than in Group D. The palpebral lobes are broad and flat.

Plan View. The glabella, which is slightly longer than its maximum breadth, is weakly trefoiled, being constricted at 2p in Group C and at 3p in Group D. The anterior part of the glabella is broadly rounded and well defined in Group D but tapers rather more sharply in Group C and reaches slightly farther to the anterior margin. The maximum glabellar breadth is measured from δ–δ, thereafter the glabella narrows slightly to the occipital furrow. Four lightly impressed glabellar furrows are recognisable on the dorsal exoskeleton. 1p is most strongly developed; it has a broadly arcuate course from a position somewhat anterior of the mid-point of the palpebral lobe, towards a point on the occipital furrow rather more than two thirds of the distance from the axial furrow to the sagittal line. Approximately half the distance along its course, the furrow curves more sharply towards the posterior; at this point a weak fork can be distinguished in some specimens, in others a faint pit can be seen on the line of, but separate from, the anterior section of 1p. The glabellar furrow 1p shallows noticeably towards, and fails to reach, both the occipital and axial furrows. 2p is less clearly impressed and runs parallel to the anterior section of 1p. 3p runs parallel to 2p; it is short and frequently just a faint mark on the glabella. 2p and 3p fail to reach the axial furrows. The distance between 1p and 2p is one and a half times greater than that between 2p and 3p. 4p appears as a shallow depression and can only be recognised on large specimens. A weak keel extends along the sagittal line from the posterior border of the glabella for a distance approaching one third of the total glabellar length. The occipital furrow is deep and narrow. It is arched forwards medianly and terminated laterally in deeply impressed pits, which are placed on the line of the axial furrow and orientated oblique to the occipital furrow. The occipital ring is a flat band marked by a small mesial tubercle. This ring averages one tenth of the total sagittal length of the cranidium. The frontal area is more than one quarter of the total sagittal length of the cranidium. The preglabellar area is smooth and slopes gently to a well defined anterior border furrow and is continued into the anterior area of the fixigena as a broad smooth surface sloping to the anterior border. The palpebral area is broad and flat and the posterior area of the fixigena is small. The anterior margin of the border is broadly curved; the anterior facing part of the border is marked by three to four discontinuous terrace lines, whilst the posterior part is smooth and gently declined to border furrow. In Group D the border is larger than in Group C. The anterior branch of the facial suture diverges from the glabella at angles varying between 30°–40°. γ is rounded and placed opposite to glabellar furrow 3p, and is clearly separated from the axial furrows. β is evenly rounded in Group D, where it is positioned level with the anterior border of the glabella on the line of the anterior border furrow. The palpebral lobe is long and flattened. δ is rounded and placed at approximately the same distance from the sagittal line as β. ε lies farther from the axial furrow than γ and is situated at a distance from the sagittal line approximating to half the maximum glabellar width. The posterior branch of the suture is short and turns sharply outwards at ε until a distance from the median line similar to that of δ is reached; it then runs broadly parallel to the posterior border of the cranidium and eventually cuts the border at a distance from the axial furrow approximately equal to half the width of the occipital ring. The posterior border is broadly rounded to flattened, and its length (*sag.*) approximates to half that of the occipital ring. The internal mould is imperfectly known, but the glabellar furrows are broader and more clearly impressed than on the dorsal exoskeleton.

Librigena. The cheek area is moderately inflated and slopes more steeply to the posterior border furrow than to the lateral border furrow. The eye platform widens laterally and to the posterior, but it is generally poorly defined. A broad but shallow lateral border furrow defines the lateral border. This border is triangular in cross section; the outward facing surface is steeper than that facing inwards and is ornamented by four to five discontinuous terrace lines. The posterior border furrow, which has an open V-shaped cross section, unites with the lateral border furrow and continues for a short distance into the genal spine. The posterior border is only weakly inflated, and about two thirds of the width of the lateral border. The genal spine is short (about one half the maximum breadth of the librigena) and sturdy, being ornamented by two to three fine lines. The eye, which is large and crescentic, rises more steeply from the cheek area posteriorly than anteriorly. Its visual surface is smooth, and evenly convex and is separated from the cheek area by a weak groove. The doublure is flat and its breadth is comparable to that of the lateral border. Its surface is irregularly pitted and ornamented by six fine lines parallel to the margin of the cheek. The free border of the doublure is slightly recurved dorsally.

Pygidium. Plan View. In outline, the pygidium is longitudinally elliptical but specimens of Group A are more rounded than those of Group B. The length of the pygidium is more than three fifths of the breadth, and the axis is narrow, ranging between one fifth and one third of the pygidium breadth. In Group B, the axis narrows evenly between straight axial furrows, but it constricts slightly between rings 7 and 8 in Group A. The posterior termination of the axis is rounded and reaches to the border furrow in small specimens of both groups, but it becomes proportionately shorter with the increase in size and then stands clear of the border. 18 (+2) rings may be recognised, of these 14–15 are clear for the posterior segmentation is indistinct. Narrow ring furrows reach to the axial furrows in segments 1–8, but thereafter they weaken at the axial furrows and become less distinct. The dorsolateral parts of the rings are marked by weak longitudinal notches which define a weakly inflated area. These notches are deepest at the anterior border of the rings, and shallow rapidly to the posterior and do not affect the posterior border. Longitudinal grooves produced by the notches are developed with varying intensity; they are best shown in small specimens, particularly those of Group B. Rings of the larger specimens are more characteristically narrow flattened bands.

12 (+2) weakly S-shaped ribs may be recognised; of these 8–9 are clear. The pleural grooves of ribs 1–4 are well defined, narrow and deep, and reach almost from the axial furrow to the border. Thereafter the grooves become progressively less well defined, shallower and broader and fail to reach to the border furrow. All of the anterior ribs are notched at the border. Smaller specimens show ribs with flattened to broadly rounded cross section, but the ribs of larger specimens are triangular in cross section and show crestal lines either medianly or slightly posteriorly placed, and with a steeper fall to the posterior pleural furrow than to the anterior. This crestal line may be traced from the axial furrow across the flattened section of the pleural lobes. Interpleural furrows are faint, and not always recognised on all ribs; their presence has been recorded up to rib 8. The furrows which are medianly or slightly posteriorly placed on the rib are clear at the axial furrow but become less well defined towards the periphery. The border is flattened to weakly convex, and declines towards the margin. Initially narrow, it widens posteriorly and attains its maximum width at rib 5. In Group A, this width is maintained, but in Group B the maximum width of the border is attained at the posterior lateral part of the pygidium. The border furrow is only weakly developed.

Posterior View. In Group B, the axis shows a semicircular cross section in specimens of small and intermediate size, but the section becomes more gently convex in large specimens. In Group A, the axis is more nearly semi-circular at all sizes. The flanks are strongly rounded in all small specimens but they become distinctly flattened with increased size in Group B. Group A is more strongly rounded at all sizes. The border slopes gently to the periphery and is differentiated from the pleural lobes only by a weak concavity.

Side View. The axis curves gently down from the anterior to the posterior; occasionally the anterior part of the axis is rather flattened. All of the rings decrease in size posteriorly. The articulating half ring is distinct but narrow and the articulating furrow is sharp. The first 5–6 rings are clear in this view and are separated by deeply impressed ring furrows; the individual rings are planar and slope anteriorly to the preceding ring furrow. Thereafter the rings are flat and the ring furrows scarcely impressed. The border is clearly marked off from the axis by a well defined re-entrant angle. In young specimens the border slopes to the margin at an angle of 45°. This slope decreases and flattens in adult specimens of both Groups A and B.

The doublure is narrow and increases in breadth from the anterior margin of the pygidium towards the posterior, but it is weakly constricted postaxially. Its structure is continuous with the dorsal exoskeleton both at the periphery of the pygidium and at its anterior margin. The inner margin is free but closely applied to the ventral surface. Anteriorly the doublure is strongly inflated and evenly rounded but it becomes somewhat flattened towards the posterior. The surface of the doublure is ornamented by 7–8 terrace lines but it is not pitted or granulated.

Internal Mould. The rings are narrow and sharp and separated by wide deep furrows which decrease in intensity towards the posterior; all of the furrows are much clearer than the comparable furrows on the dorsal exoskeleton. The ribs are narrow and angular and appear as furrowed ridges between broad, deep pleural furrows. All of the ribs are much clearer and the posterior ribs extend further towards the border than on the dorsal exoskeleton. The border is clearly defined, smooth and flat.

Ornamentation. With the exception of the furrows, a fine pitting has been recorded on all parts of the cranidium; this being most strongly expressed on the median parts of the glabella. The pitting of the fixed cheeks and the border is fine and irregular and not clearly defined below magnifications of ×20. No granulations have been recorded in specimens referred to Group C, but a collection of pustules grouped at the posterior end of the glabella characterises Group D. At lower magnifications the free cheek is smooth, but at ×20 the surface is seen to be finely and irregularly pitted.

With the exception of the furrows, all dorsal surfaces of the pygidium are pitted. The pits on the rings are considerably finer than those on the pleural lobes, where they are usually, but not invariably, arranged in two rows either side of the interpleural furrow. The pits of the border are evenly distributed. The rings and border are normally finely granulated. The intensity of granulation is variable; on the ribs it is normally confined to that part of the rib posterior to the interpleural furrow, and most strongly developed on the outer two thirds of the ribs. The granulation of the border is also of variable intensity; normally the greatest concentration of granules is on the posterior-lateral part of the border. A few specimens in both Groups A and B appear to be completely smooth. Delicate, frequently sigmoidally shaped, raised lines ornament the steeper peripheral part of the border. These are oblique to the margin and usually more or less parallel to the sagittal line. Rarely the raised lines branch. Posteriorly the raised lines come to lie progressively more nearly parallel to the margin of the tail, and where preservation is complete run parallel to the margin of the tail at its extremity.

The ventral surface of the dorsal exoskeleton is smooth at low magnifications but a fine granulation of the surface can be seen at ×30.

Measurements (in mm.)	GSM.6987	BM.,I. 5056	
Length of pygidium	14·0	12·0	
Breadth of pygidium	17·5	14·5	
Length of axis	11·5	10·25	
Breadth of axis	5·0	4·0	
	BM.,I.5039	BM.,IT.101	BM.,IT.102
Length of cranidium	14·0 (est.)	6·5	7·5
Breadth of cranidium	10·0 (est.)	5·0	6·0
Length of glabella	9·75	3·75	4·75
Breadth of glabella	8·0	3·0	4·0
Breadth of cephalon	22·0		

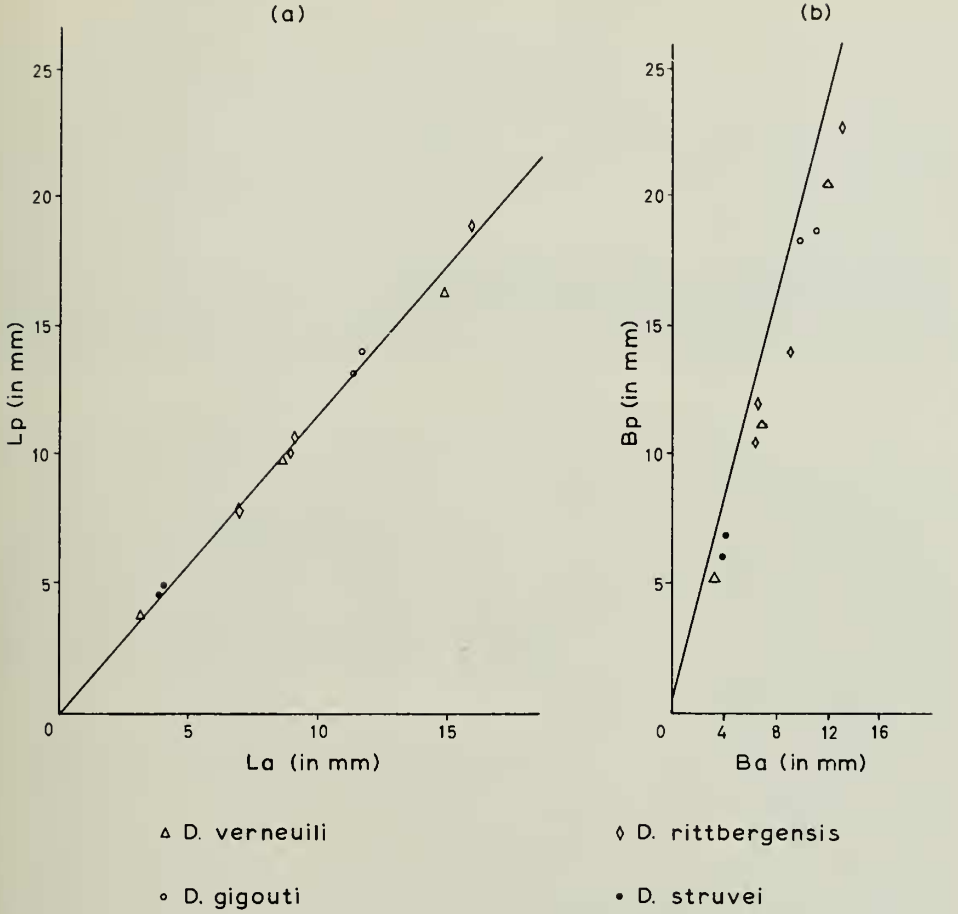

FIG. 6. Scatter diagrams showing variation in some Continental species of *Dechenella*. The appropriate reduced major axis for *Dechenella setosa* has been added to each scatter.

COMPARISONS WITH OTHER SPECIES. Arguments have been advanced in the foregoing pages in support of the contention that the specimens from Devonshire constitute a single bimorphic species with a wide range of variation. The variants of *Dechenella setosa* show many similarities to Continental species of Givetian age, and a close relationship is indicated. However, the fine and precise differences which separate these species make comparisons exceedingly difficult. Characters said to be diagnostic occur in varying combinations in the British material. This could have suggested, had less material been available, that several new species are represented. The pygidia of *Dechenella setosa* may be compared most closely to *Dechenella verneuili* (Barrande), *Dechenella rittbergensis* Zimmerman and *Dechenella gigouti* R. & E. Richter, but no single pygidium can be found which agrees exactly with the diagnoses given for these species. Scatter diagrams (Text-fig. 6) prepared from the published measurements, and measurements taken from the figures of the above species show a marked rectilinear distribution. This suggests that the species may be conspecific, and that future collecting may reveal a wider range of variation than has previously been suspected. A close relationship also exists between these scatters and those prepared for *Dechenella setosa*, for they all fall within the observed range of the British species. This is apparent on the scatter diagrams (Text-fig. 6) where the appropriate reduced major axis for *Dechenella setosa* has been added. Text-figure 6*a* is included as an example of a close correlation between the reduced major axis of *Dechenella setosa* and the scatter of the Continental species. Text-fig. 6*b* is included as an example with less perfect fit. Thus, it may prove difficult to separate these species of *Dechenella* in the future. Meanwhile, some of the more significant differences between *Dechenella setosa* and the published descriptions of other species are noted.

The number of ribs and rings present in the pygidia of *Dechenella setosa* is comparable to that in *Dechenella rittbergensis*, the number being distinctly higher than that of the other species. The shape of the pygidium, rather blunted and broadly-rounded posteriorly, is said to be closely comparable to *Dechenella gigouti* (Richter, R. & E. 1950). Although there is a similarity between *Dechenella gigouti* and the pygidium of *Dechenella setosa* figured by Richter (Pl. 1, figs. 5–7), this particular shape is distinctly unusual in the sample; by far the more common shape is that ascribed to *Dechenella verneuili*. Similarly, the very broad border of *Dechenella gigouti* is not characteristic of *Dechenella setosa*, though variants with moderately broad border, as figured by Richter, do exist.

The outline of the pygidium both in cross and long section, which is specifically important in other described species, is found to vary with size in *Dechenella setosa*. Unlike *Dechenella rittbergensis* the axis is normally separated from the post axial region by a clear re-entrant angle. The cross section of the ribs also varies with size; the rounded ribs (characteristic of *Dechenella verneuili*) are most common in small specimens, whilst those with a more flattened section (characteristic of *Dechenella rittbergensis*) and triangular section (characteristic of *Dechenella struvei* R. & E. Richter) typify the larger specimens.

The granulated surface of the test of *Dechenella setosa* would appear to distinguish the species from *Dechenella verneuili* and *Dechenella rittbergensis* which are essentially smooth forms; however, occasional smooth forms occur in both Groups A and B. Those specimens of Group A can be said to show a "*verneuili* trend", for this group has the constricted axis characteristic of *Dechenella verneuili*: the smooth forms of Group B, which have straight axial furrows can likewise be said to show a "*rittbergensis* trend". There is no regular variation of test pitting, such as has been used to distinguish between *Dechenella rittbergensis* and *Dechenella verneuili*.

The cranidia may be compared most closely to *Dechenella gigouti*, *Dechenella rittbergensis* and *Dechenella verneuili*. The broad frontal area is characteristic and serves to distinguish the species from *Dechenella rittbergensis* and *Dechenella verneuili*, but is less broad than that observed in *Dechenella gigouti*, where the length of the frontal area is equal to half the glabellar length. The presence of terrace lines on the anterior border and the pitting of the surface serve to distinguish *Dechenella setosa* from *Dechenella gigouti*, which lacks both these features.

Apart from the broad border, specimens referred to Group C appear superficially like *Dechenella rittbergensis* but the glabella is less pointed and the glabellar furrows are less clearly defined. Group D, on the other hand, is more comparable to *Dechenella verneuili* but the glabella is less broad and the glabellar furrows run broadly parallel to one another.

With the knowledge of the variation in *Dechenella setosa*, it is tempting to suggest that *Dechenella rittbergensis* and *Dechenella verneuili* represent bimorphic forms of the same species, but the geographical separation of localities yielding these species renders this improbable.

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